

Length-Weight Relations for Three Commercially Important Penaeid Shrimp of the Gulf of Mexico¹

INTRODUCTION

Studies of shrimp biology frequently require knowledge of length-weight conversions because measurements of length, rather than weight, are usually recorded. Although several authors have provided length-weight relations for penaeid shrimp (Anderson and Lindner, 1958; Chin, 1960; Kutkuhn, 1962; and McCoy, 1968), most have not provided comparisons between sexes or species, and have not accounted for seasonal variation. The present study was initiated to provide relations generally applicable to a wide size range of brown shrimp, *Penaeus aztecus* Ives, white shrimp, *Penaeus setiferus* (Linnaeus), and pink shrimp, *Penaeus duorarum* Burkenroad, of each sex on a year-round basis.

COLLECTION AND MEASUREMENT OF SHRIMP

Shrimp collected and measured for this study were obtained from two areas. The brown and white shrimp were caught along the upper Texas coast, and the pink shrimp were taken on the Florida Tortugas grounds. Brown shrimp were collected in the winter, spring, summer, and autumn; white shrimp in the winter, spring, and autumn; and pink shrimp in the winter, spring, and summer. The numbers of shrimp taken each season are listed by sex in Table 1.

By using samples taken during different seasons, we were able to include a wider range of sizes than was present in any single sample, and to establish relations relatively free from seasonal bias. In the laboratory, total length (tip of rostrum to the tip of the telson) was measured to the nearest millimeter and total weight to the nearest tenth of a gram. The length-frequency distributions of measured shrimp by species and sex are presented in Table 2.

¹ Contribution Number 305, Bureau of Commercial Fisheries Biological Laboratory, Galveston, Texas 77550.

TABLE 1.—*The number of shrimp, by species and sex, collected each season*

Species and sex	Month			
	June	September	December	March
Brown				
Male	385	367	324	320
Female	466	609	496	445
White				
Male	126	0	579	265
Female	121	0	647	352
Pink				
Male	340	405	0	428
Female	742	629	0	754

LENGTH-WEIGHT RELATIONS

Length-weight relations were calculated with the equation $W = aL^b$, where W is weight in grams, L is total length in millimeters, and "a" and "b" are constants. Relations were developed for each sex of each species, combining data from all seasons (Table 3). On the basis of confidence intervals for the constant "b," we concluded that the relations for male and female shrimp of the individual species were as follows: (1) white shrimp, not significantly different; (2) pink shrimp, significantly different; and (3) brown shrimp, significantly different at the 90% level, but not at the 95% level. One length-weight relation (sexes combined) for each species was calculated giving each sex equal weight (Table 3).

DISCUSSION

The relation for white shrimp is similar to that presented by Chin (1960), but weights calculated from our relation for brown shrimp differ from his for shrimp above 120 mm. Chin did not develop separate relations for the

TABLE 2.—*Length-frequency distributions used in length-weight calculations*

Length (milli- meters)	Species					
	Brown		White		Pink	
	Male	Female	Male	Female	Male	Female
	----- Number -----					
45- 49	1	0	0	0	0	0
50- 54	1	0	0	0	0	0
55- 59	3	2	0	0	0	0
60- 64	7	7	0	0	0	1
65- 69	26	11	0	0	0	0
70- 74	30	30	1	1	5	12
75- 79	30	30	1	2	49	25
80- 84	30	30	1	6	82	55
85- 89	32	33	10	12	92	82
90- 94	34	33	26	18	101	83
95- 99	36	37	30	30	137	102
100-104	41	37	30	30	121	100
105-109	66	46	30	30	135	142
110-114	75	58	30	30	101	136
115-119	106	70	30	32	79	141
120-124	120	86	32	32	75	129
125-129	101	85	33	34	64	114
130-134	94	109	39	33	43	102
135-139	91	114	35	49	40	100
140-144	91	102	52	60	15	89
145-149	90	98	60	60	15	86
150-154	92	92	63	59	7	82
155-159	69	92	76	61	6	82
160-164	41	75	90	63	3	86
165-169	41	73	90	71	2	95
170-174	26	76	90	75	1	83
175-179	14	75	71	90	0	90
180-184	3	80	27	90	0	46
185-189	2	83	16	67	0	36
190-194	2	85	5	45	0	16
195-199	0	62	2	25	0	4
200-204	1	55	0	7	0	4
205-209	0	46	0	4	0	1
210-214	0	44	0	4	0	1
215-219	0	24	0	0	0	0
220-224	0	23	0	0	0	0
225-229	0	7	0	0	0	0
230-234	0	4	0	0	0	0
235-239	0	2	0	0	0	0
Total	1,396	2,016	970	1,120	1,173	2,125

sexes, indicate the size range of shrimp sampled, or make adjustments for the fact that females were more abundant than males in his samples.

Estimates of weights of white shrimp between 160 mm and 195 mm made from the

TABLE 3.—*Equations describing the length-weight relations for brown, white, and pink shrimp*

Species and sex	Equation	Confidence interval for b at 95-percent level	Number measured
Brown			
Male	$\text{Log } W = -4.935 + 2.911 \text{ Log } L$	$2.911 \pm .026$	1,396
Female	$\text{Log } W = -5.021 + 2.966 \text{ Log } L$	$2.966 \pm .032$	2,016
Combined	$\text{Log } W = -4.978 + 2.938 \text{ Log } L$	$2.938 \pm .024$	3,412
White			
Male	$\text{Log } W = -5.694 + 3.261 \text{ Log } L$	$3.261 \pm .033$	970
Female	$\text{Log } W = -5.635 + 3.234 \text{ Log } L$	$3.234 \pm .032$	1,120
Combined	$\text{Log } W = -5.665 + 3.247 \text{ Log } L$	$3.247 \pm .028$	2,090
Pink			
Male	$\text{Log } W = -4.999 + 2.967 \text{ Log } L$	$2.967 \pm .037$	1,173
Female	$\text{Log } W = -5.227 + 3.092 \text{ Log } L$	$3.092 \pm .025$	2,125
Combined	$\text{Log } W = -5.113 + 3.029 \text{ Log } L$	$3.029 \pm .022$	3,298

graph for mature shrimp presented by Anderson and Lindner (1958) are from 1 to 6 grams heavier than estimates made from Chin's data, and from 1 to 4 grams heavier than estimates based on the relation established in this paper. Anderson and Lindner noted that mature shrimp were heavier than immature individuals of the same length, and that this difference caused seasonal changes in the length-weight relation.

The estimates of "b" for sexes combined presented by McCoy (1968) are not significantly different from 3.0 for either pink or brown shrimp smaller than 160 mm. He based his calculations on measurements of both sexes but did not indicate the sex ratio, the size distribution of his samples, or the dates of sampling.

Kutkuhn (1962) showed a pronounced sexual difference in the relations calculated for pink shrimp and noted some seasonal variation in the relations. Although he concluded that seasonal variation was not of practical significance, relations based on shrimp collected in a single season may be unsuitable for general use. Kutkuhn did not present a relation for the sexes combined, but the relations we established for male and female pink shrimp are nearly the same as his. Kutkuhn found that "b" was significantly greater than 3.0 for both sexes, whereas we found that the value for males is not different from 3.0 at the 95% level of significance.

LITERATURE CITED

- ANDERSON, W. W., AND M. J. LINDNER. 1958. Length-weight relation in the common or white shrimp, *Penaeus setiferus*. U. S. Fish Wildl. Serv., Spec. Sci. Rept., Fish. 256, 13 pp.
- CHIN, E. 1960. The bait shrimp fishery of Galveston Bay, Texas. Trans. Amer. Fish. Soc. 89(2): 135-141.
- KUTKUHN, J. H. 1962. Dynamics of a penaeid shrimp population and management implications. U. S. Fish Wildl. Serv., Fish. Bull. 65(2): 313-338.
- MCCOY, E. G. 1968. Migration, growth and mortality of North Carolina pink and brown penaeid shrimps. North Carolina Dept. Cons. and Devel., Spec. Sci. Rept. 15, 26 pp.

C. T. FONTAINE
R. A. NEAL

*Bureau of Commercial Fisheries
Biological Laboratory
Galveston, Texas 77550*